Asian Journal of Probability and Statistics

Volume 25, Issue 1, Page 57-65, 2023; Article no.AJPAS.106923
ISSN: 2582-0230

Assessing Risk Factors of Diabetes Mellitus based on Rural-urban Residence in Bangladesh: Findings from Two Cross Sectional Surveys

Salma Akter [a], Shahanaj Parvin [a], Most Sifat Muntaha Soni [b*], Md. Ismail Hossain [a], Shahjadi Ireen [a], Rebeka Sultana [a] and Mansura Begum [a]

[a] Department of Statistics, Jagannath University, Dhaka-1100, Bangladesh.
[b] Department of Statistics, Islamic University, Kushtia, Bangladesh.

Authors' contributions

This work was carried out in collaboration among all authors. Authors MSMS, SI, SA conceived and designed the experiments, performed the experiments, contributed reagents, materials, analysis tools or data. Authors MIS, SP, MB and RS performed the experiments, contributed reagents, materials, analysis tools or data, analyzed and interpreted the data and wrote the paper. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AJPAS/2023/v25i1538

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/106923

Original Research Article

Received: 18/07/2023
Accepted: 23/09/2023
Published: 25/09/2023

Abstract

Background: Diabetes mellitus is a rising global health issue that causes a number of health complications and is becoming increasingly prevalent in countries with low and medium incomes. The objective of the study is to assess the changes of the prevalence and associated risk factors of diabetes mellitus in the middle-aged and elderly population in urban and rural areas of Bangladesh between the years 2011 and 2018.

**Corresponding author: Email: sifatmuntahasbi@gmail.com;*

Methods: The relationship between the outcome variables and the covariates was evaluated using a chi-square test. In order to identify the risk factors strongly linked to diabetes mellitus, two distinct multivariate binary logistic regression models were utilized (one for urban and the other for rural areas).
Results: In 2011 there were 8.3% of respondents who had diabetes, and 11% in 2017–18. Multivariate analysis of the determinants of diabetes status in relation to place of residence revealed a significant impact on age, education, wealth status, region, and survey year. Diabetes risk was lower in rural Bangladesh (OR = 0.87), according to the odds ratio. In terms of fixed effects, the risk of diabetes was significantly 2.34 times higher for rich households compared to poor urban households, whereas the risk was 1.98 times higher for rural households. Unemployed respondents had a higher risk of diabetes (OR = 1.33 for urban and OR = 1.31 for rural residences) than employed respondents. Both urban and rural respondents without hypertension were at less risk of diabetes than those with hypertension (OR = 0.73 for urban and OR = 0.77 for rural).
Conclusion: A large proportion of the adult population in Bangladesh suffers from diabetes. Different health education programs are required to develop appropriate strategies, including proper weight control, physical activity, and healthier eating habits to prevent the prevalence of diabetes in Bangladesh.

Keywords: Diabetes; risk factors; covariates; prevalence.

1 Introduction

Diabetes mellitus (DM), a chronic metabolic disease, is a major public health problem worldwide [1]. Past few decades, diabetes mellitus has consistently ranked among the top 10 global causes of death [2]. Type 1 diabetes affects 5 to 10% of the population, while Type 2 diabetes affects 90 to 95% of the population [3]. By 2021, a total of 537 million adults worldwide will be affected by diabetes [4].

Sub-Saharan Africa is expected to see the largest increase in the number of people with diabetes compared to any other region by 2040, with more than half of those affected being unaware of their diabetes status [5]. In Southeast Asia, 1 of every 11 adults (90 million) has diabetes. In Bangladesh 4.05% of total death caused by diabetes, 28976 numbers of total death [6,7]. Approximately 80% of adults with diabetes are from low-and middle-income countries around the world [7]. Bangladesh has experienced an epidemiological transition in the past few years from communicable diseases to non-communicable diseases [8].

A recent study of meta-analysis revealed that the overall rate of diabetes mellitus in Bangladesh's population was 8% [9]. Diabetes is increasing in Bangladesh as a result of rapid urbanization, reduced physical activity, unhealthy eating patterns, increased cigarette use, and cardiovascular disorders. The study also indicates significant regional differences in the prevalence of diabetes (6% to 19%) in Bangladesh [10]. Because of this disease, several other health complications arise that may affect the entire body.

The causes of having diabetes mellitus, are diverse and complex. Previous studies based on Demographic and Health Survey (DHS) data have attempted to discover the risk factors for diabetes mellitus status. Age, sex, education, wealth status, working status, caffeinating drink, residence etc. were most important determinants that were associated with diabetes status. A meta-analysis including 22 studies by Li et al., [11] showed that the prevalence to develop diabetes mellitus increases with increases in respondent age group. Liu et al. [12] investigated the relationship between maternal ethnicity, maternal age at delivery, and the risk of Gestational Diabetes Mellitus (GDM) and showed that Asian women have higher of odds of GDM diagnosis. Another study used a two-level logistic regression model to investigate the prevalence of diabetes mellitus and its contributing factors in Bangladesh. It found that the likelihood of having DM was higher in female participants, higher educated participants, people from wealthy families, and people with hypertension [13].

Marbaniang et al. [14] observed that the risk of respondents having diabetes increased along with their age. Increasing age is a potential risk factor to develop diabetes as with an increase in age, physical activity declines, leading to the onset of diabetes. The richest wealth quintile was more likely to have diabetes than their poor counterparts [14]. Due to residential heterogeneity in Bangladesh, it was unclear how common diabetes was and what risk factors were related to it. Based on this gap, the purpose of this study is to investigate the prevalence of diabetes mellitus (DM) and its associated factors across middle-aged and elderly people in all residential areas in Bangladesh. The results of this study could help policy makers of Bangladesh to develop evidence-based interventions to control diabetes.

2 Materials and Methods

2.1 Data source

A nationally representative secondary data was used for this study named "Bangladesh Demographic and Health Survey (BDHS)". which was implemented by the National Institute of Population Research and Training (NIPORT), and funded by the United States Agency for International Development (USAID). This study conducted based on BDHS 2011 and BDHS 2017-18 survey data set.

2.2 Sample design

In this cross-sectional survey, stratified sampling was utilized in two stages. In the first stage, a list of study areas was chosen, and in the second stage, houses were chosen from each enumeration area. The survey was conducted in 18000 households with 83731 respondents (for 2011 survey) and 20250 households with 89819 respondents (for 2017-18 survey). Since this study focuses on middle age and older population (i.e., 35+), <35 aged respondents were omitted from this sample. For the further analysis purpose, data were weighted to represent the more accurate structure of Bangladeshi population using weighting factors provided with the Bangladesh Demographic and Health Survey. For hypertension study, after weighing, 7838 (for 2011 survey) and 7133 (for 2017-18 survey) 35+ aged respondents included in this study. After combining the two datasets, 14971 adults were used for the analysis. According to diabetes mellitus study, 7543 respondents were included in 2011 survey and 6680 respondents were included in 2017-18 survey, and after combing two datasets, there were 14222 middle age and older respondents included as a sample for further analysis.

2.3 Dependent variable

According to World Health Organization (WHO) guidelines, the presence of diabetes was considered if the fasting plasma glucose level was ≥7.0 mmol/L.

2.4 Independent variable

This study dealt with numerous independent variables. The independent variables were respondents age, sex, educational status, wealth status, working status, having hypertension, drink coffee/tea, region, and residence. Respondents ages were classified into four groups: 35-44, 45-54, 55-64 and 64+.There were three categories for respondents' education levels: no education, primary education, and secondary education or above. Respondents' wealth status was subdivided into poor, middle, and rich classes. The categories for working status were yes and no. Respondents were asked whether they drank coffee or tea. If they drank any of them, it was considered as yes, otherwise no. There was a yes/no category for hypertension. The residences of the respondents were categorized as urban and rural. This study divided the whole Bangladesh into four regions: Northern, Eastern, Central, and Southern. Since this study used two survey data sets, the survey year (2011 and 2017–18) was regarded as an independent variable.

2.5 Statistical analysis

The characteristics of the respondents were explained in this study using descriptive statistics. To investigate the relationship between the dependent variable and the independent variables, we used bivariate analysis. The chi-square statistics was used to test for independence. Binary logistic regression was applied to assess the effect of an independent variables on dependent variable. Data management and analysis were performed using SPSS (Statistical Package for Social Science) version 25 and R-Programming version 4.0.0.

3 Results

Table 1 represents basic demographic and socio-economic characteristics for diabetes mellitus study such as, respondent age, respondent sex, respondent education, wealth status, currently working, having hypertension, drinking coffee/tea, region, residence and survey year. In this section, about half of the respondents were female (51%) and most of the respondents were middle aged (36.1%). More than one third portion of the total respondents were illiterate (45%). The majority of the participants were from poor and rich classes

(approximately, 40%, each). 55.8% of the respondents were working outside of the home, and more than two-thirds of the respondents had hypertension problems. Majority of the respondent comes from central region of Bangladesh (39%), and 76% were from rural residents of Bangladesh. Moreover, as per Table 1, there were more respondents in 2011 (53%) as compared to 2017–18 (47%).

Table 1. Percentage distribution of the selected variables for diabetes mellitus

Variables	*Frequency (n=14,222)*	*Percentage (%)*
Respondent age (in years)		
35-44	5128	36.1
45-54	3894	27.4
55-64	2651	18.6
≥65	2549	17.9
Respondent sex		
Male	6962	49.0
Female	7260	51.0
Respondent education		
No education	6426	45.2
Primary education	4120	19.0
Secondary and above	3677	25.9
Wealth status		
Poor	5640	39.7
Middle	2873	20.2
Rich	5710	40.1
Currently working		
Yes	7933	55.8
No	6285	44.2
Hypertension		
Yes	9953	70.1
No	4244	29.9
Drinking coffee/tea		
Yes	830	5.8
No	13368	94.2
Region		
Northern	3189	22.4
Eastern	2755	19.4
Central	5542	39.0
Southern	2737	19.2
Residence		
Urban	3399	23.9
Rural	10823	76.1
Years		
2011	7543	53.0
2017-18	6680	47.0

The prevalence of diabetes mellitus status and the background characteristics of the covariates were shown in Table 2. From the χ^2 test, all the covariates were significantly associated with Diabetes except sex. The percentage of respondents with diabetes was found to be higher for older age (55-64 years) (approximately 11 percent), respondents' secondary and higher education (13.2 percent), rich respondents (approximately 14.5 percent), being unemployed (11 percent), having hypertension (12.5 percent), drinking any coffee or tea (12.4 percent), being from the eastern region of Bangladesh (12.3 percent), being from an urban area (13.5 percent), and for the 2017-18 survey year (11 percent).

In Table 3, the results of the binary logistic regression model are presented. From this Table 3, it was clear that the risk of diabetes was lower in rural Bangladesh (OR = 0.87). Considering fixed effects, the odds ratio of having diabetes was significantly higher for the older age group of respondents. The risk of developing diabetes mellitus was 34%, 44%, and 25% greater for respondents aged 45–54, 55–64, and > 64 among all rural

respondents, respectively, than for respondents aged 35–44. This study found significant only in the 45-54 year (OR = 1.37) and 55-64 year (OR = 1.67) age groups in urban residences. The rich were 2.34 times more likely to have diabetes than the poor in the urban area, while the rural area was 1.98 times more likely. As observed in Table 3, there was a significant association between the respondent's educational level and diabetes status. In the urban area, respondents with secondary and higher education had a 72% higher risk of diabetes than uneducated respondents. This risk was 37% higher in rural areas.

Table 2. Association between selected variables and diabetes mellitus status among middle aged and older population in Bangladesh

Variables	*Diabetes mellitus status*			
	No (%)	*Yes (%)*	χ^2 *value*	*p-value*
Respondent age (in years)				
35-44	91.9	8.1	24.95	<0.001
45-54	89.9	10.1		
55-64	88.6	11.4		
≥65	90.1	9.9		
Respondent sex				
Male	90.6	9.4	0.75	0.39
Female	90.2	9.8		
Respondent education				
No education	92.7	7.3	93.66	<0.001
Primary education	90.2	9.8		
Secondary and above	86.8	13.2		
Wealth status				
Poor	94.1	5.9	272.69	<0.001
Middle	93.0	7.0		
Rich	85.5	14.5		
Currently working				
Yes	91.6	8.4	27.64	<0.001
No	89.0	11.0		
Hypertension				
Yes	87.5	12.5	60.67	<0.001
No	91.7	8.3		
Drinking coffee/tea				
Yes	87.6	12.4	8.25	0.004
No	90.6	9.4		
Region				
Northern	92.5	7.5	46.59	<0.001
Eastern	87.7	12.3		
Central	89.9	10.1		
Southern	91.7	8.3		
Residence				
Urban	86.5	13.5	80.58	<0.001
Rural	91.7	8.3		
Years				
2011	91.7	8.3	28.64	<0.001
2017-18	89.0	11.0		

Unemployed respondents had a higher risk of diabetes than employed respondents (OR = 1.33 for urban and OR = 1.31 for rural residences in Bangladesh). Both urban and rural respondents without hypertension were at less risk of diabetes than those with hypertension (OR = 0.73 for urban and OR = 0.77 for rural). The region was not a significant factor among urban residences in Bangladesh. But, the eastern part of Bangladesh showed a 61 percent greater risk of diabetes among rural populations than the northern part.

Table 3. Binary logistic regression analysis showing the risk of diabetes mellitus status among middle and older aged population by background characteristics in urban and rural residence

Variables	Full sample			Urban sample			Rural sample		
	OR	**95% CI**	**P-value**	**OR**	**95% CI**	**P-value**	**OR**	**95% CI**	**P-value**
Respondent age (in years)									
35-44 (ref.)	1			1			1		
45-54	1.34	1.16 – 1.56	**<0.001**	1.37	1.07 – 1.77	**0.01**	1.34	1.11 – 1.61	**0.002**
55-64	1.50	1.27 – 1.77	**<0.001**	1.67	1.26 – 2.22	**<0.001**	1.44	1.18 – 1.76	**<0.001**
≥65	1.24	1.04 – 1.48	**0.02**	1.25	0.89 – 1.75	0.19	1.25	1.01 – 1.55	**0.04**
Respondent education									
No education (ref.)	1			1			1		
Primary	1.31	1.14 – 1.52	**<0.001**	1.33	1.00 – 1.78	**0.05**	1.31	1.10 – 1.55	**0.002**
Secondary+	1.49	1.28 – 1.74	**<0.001**	1.72	1.31 – 2.24	**<0.001**	1.37	1.13 – 1.66	**0.002**
Wealth status									
Poor (ref.)	1			1			1		
Middle	1.07	0.89 – 1.29	0.47	0.90	0.51 – 1.60	0.721	1.11	0.92 – 1.35	0.28
Rich	2.06	1.76 – 2.40	**<0.001**	2.34	1.51 – 3.61	**<0.001**	1.98	1.67 – 2.35	**<0.001**
Working status									
Yes (ref.)	1			1			1		
No	1.34	1.18 – 1.51	**<0.001**	1.33	1.07 – 1.64	**0.009**	1.31	1.13 – 1.53	**0.001**
Hypertension									
Yes (ref.)	1			1			1		
No	0.76	0.67 – 0.86	**<0.001**	0.73	0.59 – 0.90	**0.004**	0.77	0.66 – 0.90	**0.001**
Drink coffee									
Yes (ref.)	1			1			1		
No	0.85	0.68 – 1.07	0.17	0.92	0.63 – 1.35	0.68	0.84	0.63 – 1.12	0.24
Region									
Northern (ref.)	1			1			1		
Eastern	1.42	1.19 – 1.71	**<0.001**	1.03	0.71 – 1.50	0.875	1.61	1.31 – 1.98	**<0.001**
Central	1.26	1.07 – 1.48	**0.006**	1.34	0.96 – 1.85	0.081	1.19	0.98 – 1.44	0.08
Southern	1.00	0.83 – 1.22	0.98	1.15	0.78 – 1.70	0.470	0.95	0.76 – 1.19	0.64
Residence									
Urban (ref.)	1								
Rural	0.87	0.77 – 1.00	**0.05**						
Survey year									
2011 (ref.)	1			1			1		
2017-18	1.37	1.22 – 1.55	**<0.001**	1.45	1.18 – 1.79	**0.001**	1.34	1.15 – 1.55	**<0.001**

4 Discussion

This study shows the variation in diabetes mellitus between urban and rural Bangladesh. Diabetes was more prevalent in urban than rural areas in Bangladesh. A study of the Ethiopia produced similar findings [5]. The older age groups had a higher prevalence of diabetes in both residential areas. Evidence from several studies shows the consistency with this finding [10,15]. Significant correlations were found between diabetes risk and education level. This finding was made in both urban and rural settings. Previous studies conducted by various research confirmed that increase in education may increase the risk of having diabetes mellitus [15-17]. Respondents from middle and rich families had a higher risk of developing diabetes mellitus than respondents from poor backgrounds in both areas. The results of the present study aligned with those of other earlier studies [18–20]. However, this study also shows that the prevalence of diabetes was higher among wealthy urban residents than rural residents.

In terms of working status and diabetes risk, results were nearly identical in rural and urban areas. The probability of developing diabetes was lower among employed people than among unemployed people. This

outcome matched a research precisely [21]. Several studies also showed moderate or high physical activities were inversely related to diabetes mellitus prevalence [15,22-24]. Workers who were less active had an increased risk of developing diabetes [25]. According to a Peruvian study, people in urban areas had greater blood pressure and blood sugar levels than those in rural areas [26]. This study found that individuals from both urban and rural areas who did not have hypertension had a lower risk of developing diabetes. This result is consistent with prior research [21]. An earlier study found that drinking coffee and the risk of diabetes were significantly related [25]. The conflicting results were found in this study in both residential areas.

Prior studies found significant regional variation in the risk of diabetes in Bangladesh [10,25,21]. According to this study, the risk of diabetes among urban Bangladeshi inhabitants was not significantly influenced by geographic location. In rural areas, the risk of diabetes was only positively connected with the eastern region. However, compared to the northern part of Bangladesh, the eastern region revealed a higher incidence of diabetes among rural inhabitants. The same findings came from a study that combined both rural and urban locations [10]. The opposite outcome was also found in a different study [21].

5 Conclusion

The rate of developing diabetes mellitus is growing substantially in Bangladesh. In this study, the prevalence of diabetes mellitus in Bangladesh was determined and provides comprehensive summary estimates of the rate of diabetes mellitus along with their trend. This study indicates that diabetes prevalence in Bangladesh is high and increasing. The findings of the study also suggest that respondent age, education, wealth status, working status, and geographical region are strongly related to high risk of developing diabetes among the people of Bangladesh. Therefore, risk factor prevention-based health interventions could aid in lowering the prevalence of diabetes. The government should launch the appropriate campaigns to educate young people about important issues, such as providing extra care for the elderly and those who are at high risk of developing diabetes.

Disclaimer

This paper is an extended version of a preprint document of the same author.

The preprint document is available in this link: https://www.researchsquare.com/article/rs-2957385/v1 [As per journal policy, preprint article can be published as a journal article, provided it is not published in any other journal]

Acknowledgements

We thank the Demographic Health Survey for allowing us to use data from the Bangladesh Demographic Health Survey for our study.

Competing Interests

Authors have declared that no competing interests exist.

References

[1] International Diabetes Federation. IDF Diabetes Atlas, 10th Edition [cited 2021]. Available: http://www.diabetesatlas.org/.

[2] World Health Organization. The Top 10 Causes of Death. [online] World Health Organization; 2020. Available at: https://www.who.int/news-room/fact-sheets/detail/the-top-10-causes-of-death [Accessed 16 Jul. 2022].

[3] Deshpande AD, Harris-Hayes M, Schootman M. Epidemiology of Diabetes and Diabetes-Related Complications. Physical Therapy. 2008;88(11):1254–1264. DOI:10.2522/ptj.20080020.

[4] Sun H, Saeedi P, Karuranga S, Pinkepank M, Ogurtsova K, Duncan BB, Stein C, Basit A, Chan JCN, Mbanya JC, Pavkov ME, Ramachandaran A, Wild SH, James S, Herman WH, Zhang P, Bommer C, Kuo

S, Boyko EJ, Magliano DJ. IDF Diabetes Atlas: Global, Regional and country-level Diabetes Prevalence Estimates for 2021 and Projections for 2045. Diabetes Research and Clinical Practice. 2021;183(10267): p.109119.
DOI:10.1016/j.diabres.2021.109119.

[5] Zekewos A. Loha E, Egeno T, Wubshet K, Merga Z. Prevalence of diabetes mellitus and associated factors in Southern Ethiopia: A community based study. Ethiopian Journal of Health Sciences. 2018;28(4):451–460.
DOI:10.4314/ejhs.v28i4.11.

[6] Mohiuddin A). Diabetes fact: Bangladesh perspective. International Journal of Diabetes Research. 2019;2(1):14–20.
DOI:10.17554/ijdr.v2i1.2457.

[7] International Diabetes Federation. IDF Diabetes Atlas 9thEdition; 2019. [online]
Available:www.diabetesatlas.org.
Available: https://www.diabetesatlas.org/en/ [Accessed 25 Sep. 2021].

[8] Ahsan Karar Z, Alam N, Kim Streatfield P. Epidemiological Transition in Rural Bangladesh, 1986–2006. Global Health Action. 2009;2(1):1904.
DOI:10.3402/gha.v2i0.1904.

[9] Akhtar S, Nasir JA, Sarwar A, Nasr N, Javed A, Majeed R, Salam MA, Billah B. Prevalence of diabetes and pre-diabetes in Bangladesh: A systematic review and meta-analysis. BMJ Open. 2020;10(9):p.e036086.
DOI:10.1136/bmjopen-2019-036086.

[10] Roy PK, Khan MHR, Akter T, Rahman MS. Exploring socio-demographic-and geographical-variations in Prevalence of Diabetes and Hypertension in Bangladesh: Bayesian Spatial Analysis of National Health Survey Data. Spatial and Spatio-temporal Epidemiology. 2019;29:71–83.
DOI:10.1016/j.sste.2019.03.003.

[11] Li Y, Ren X, He L, Li J, Zhang S, Chen W. Maternal age and the risk of gestational diabetes mellitus: A systematic review and meta-analysis of over 120 million participants. Diabetes Research and Clinical Practice. 2020;162:108044.
DOI:10.1016/j.diabres.2020.108044.

[12] Liu B, Lamerato LE, Misra DP. A retrospective analysis of the relationship between race/ethnicity, age at delivery and the risk of gestational diabetes mellitus. The Journal of Maternal-Fetal & Neonatal Medicine. 2019;1–9.
DOI:10.1080/14767058.2019.1566310.

[13] Talukder A, Hossain MZ. Prevalence of diabetes mellitus and its associated factors in bangladesh: Application of two-level logistic regression model. Scientific Reports. 2020;10(1):1–7.
DOI:10.1038/s41598-020-66084-9.

[14] Marbaniang SP, Lhungdim H, Chauhan S, Srivastava S. Interaction of multiple risk factors and population attributable fraction for type 2 diabetes and hypertension among adults aged 15–49 years in northeast india. Diabetes & Metabolic Syndrome: Clinical Research & Reviews. 2021;15(5):102227.
DOI:10.1016/j.dsx.2021.102227.

[15] Mutyambizi C, Pavlova M, Hongoro C, Groot W. Inequalities and Factors Associated with Adherence to Diabetes self-care Practices Amongst Patients at Two Public Hospitals in Gauteng, South Africa. BMC Endocrine Disorders. 2020;20(1).
DOI:10.1186/s12902-020-0492-y.

[16] Aekplakorn W, Chariyalertsak S, Kessomboon P, Assanangkornchai S, Taneepanichskul S, Putwatana P. Prevalence of Diabetes and Relationship with Socioeconomic Status in the Thai Population: National Health Examination Survey, 2004–2014. Journal of Diabetes Research. 2018;:1–8.
DOI:10.1155/2018/1654530.

[17] Menke A, Casagrande S, Geiss L, Cowie CC. Prevalence of and Trends in Diabetes among Adults in the United States, 1988-2012. JAMA. 2015;314(10):1021.
DOI:10.1001/jama.2015.10029.

[18] Gupta RD, Chakraborty PA, Hossain Md. B. Association of household wealth and education level with hypertension and diabetes among adults in bangladesh: A propensity score-based analysis. Tropical Medicine & International Health. 2021;26(9):1047–1056.
DOI:10.1111/tmi.13625.

[19] Corsi DJ, Subramanian SV. Socioeconomic Gradients and Distribution of Diabetes, Hypertension, and Obesity in India. JAMA Network Open. 2019;2(4):e190411.
DOI:10.1001/jamanetworkopen.2019.0411.

[20] Papier K, Jordan S, D'Este C, Bain C, Peungson J, Banwell C, Yiengprugsawan V, Seubsman S, Sleigh A. Incidence and Risk Factors for Type 2 Diabetes Mellitus in Transitional Thailand: Results from the Thai Cohort Study. BMJ Open. 2016;6(12):e014102.
DOI:10.1136/bmjopen-2016-014102.

[21] Hossain MB, Khan Md. N, Oldroyd JC, Rana J, Magliago DJ, Chowdhury EK, Karim MN, Islam RM. Prevalence of, and Risk Factors for, Diabetes and Prediabetes in Bangladesh: Evidence from the National Survey Using a Multilevel Poisson Regression Model with a Robust Variance. PLOS Global Public Health. 2022;2(6):e0000461.
DOI:10.1371/journal.pgph.0000461.

[22] González K, Fuentes J, Márquez JL. Physical Inactivity, Sedentary Behavior and Chronic Diseases. Korean Journal of Family Medicine. 2017;38(3):111.
DOI:10.4082/kjfm.2017.38.3.111.

[23] Allen L, Williams J, Townsend N, Mikkelsen B, Roberts N, Foster C, Wickramasinghe K. Socioeconomic Status and non-communicable Disease Behavioural Risk Factors in low-income and lower-middle-income countries: a Systematic Review. The Lancet Global Health. 2017;5(3):e277–e289.
DOI:10.1016/s2214-109x(17)30058-x

[24] Ali N, Akram R, Sheikh N, Sarker AR, Sultana M. Sex-specific prevalence, Inequality and Associated Predictors of hypertension, diabetes, and Comorbidity among Bangladeshi adults: Results from a Nationwide cross-sectional Demographic and Health Survey. BMJ Open. 2019;9(9):e029364.
DOI:10.1136/bmjopen-2019-029364.

[25] Sathi NJ, Islam Md. A, Ahmed Md. S, Islam SMS. Prevalence, Trends and Associated Factors of Hypertension and Diabetes Mellitus in Bangladesh: Evidence from BHDS 2011 and 2017–18. Plos One. 2022;17(5):e0267243.
DOI:10.1371/journal.pone.0267243.

[26] Miranda JJ, Gilman RH, Smeeth L. Differences in cardiovascular risk factors in rural, urban and rural-to-urban migrants in Peru. Heart. 2011;97(10):787-96.

Peer-review history:
The peer review history for this paper can be accessed here (Please copy paste the total link in your browser address bar)
https://www.sdiarticle5.com/review-history/106923